Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

DESIGN & TECHNOLOGY **0445/43**

Paper 4 Systems & Control **October/November 2020**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Answer in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].
- All dimensions are in millimetres.

This document has **20** pages. Blank pages are indicated.

[Turn over

Section A

Answer **all** questions in this section.

1 Circle **two** infinite energy sources from the list below.

coal **wind** **oil** **solar** **natural gas** [2]

2 **(a)** State **one** advantage of using CAD/CAM in batch production.

.....

..... [1]

(b) Name **one** manufacturing machine that can be controlled by a computer.

..... [1]

3 **(a)** Fig 3.1 shows a concrete beam used in a road bridge.

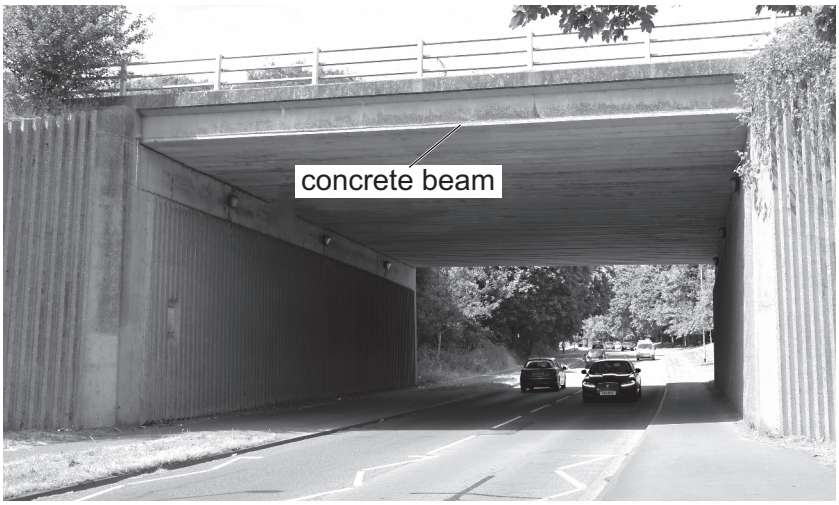


Fig. 3.1

Give **two** properties of concrete that make it suitable for this purpose.

1 .....

2 .....

[2]

(b) **(i)** Use sketches and notes to show how steel can be used to reinforce a concrete beam.

[2]

(ii) Name the main force resisted by steel in a concrete beam.

..... [1]

4 Fig. 4.1 shows details of a self-grip wrench being locked onto a nut between the jaws. The lower jaw is acting as a lever, locking onto the nut when pressure is applied.

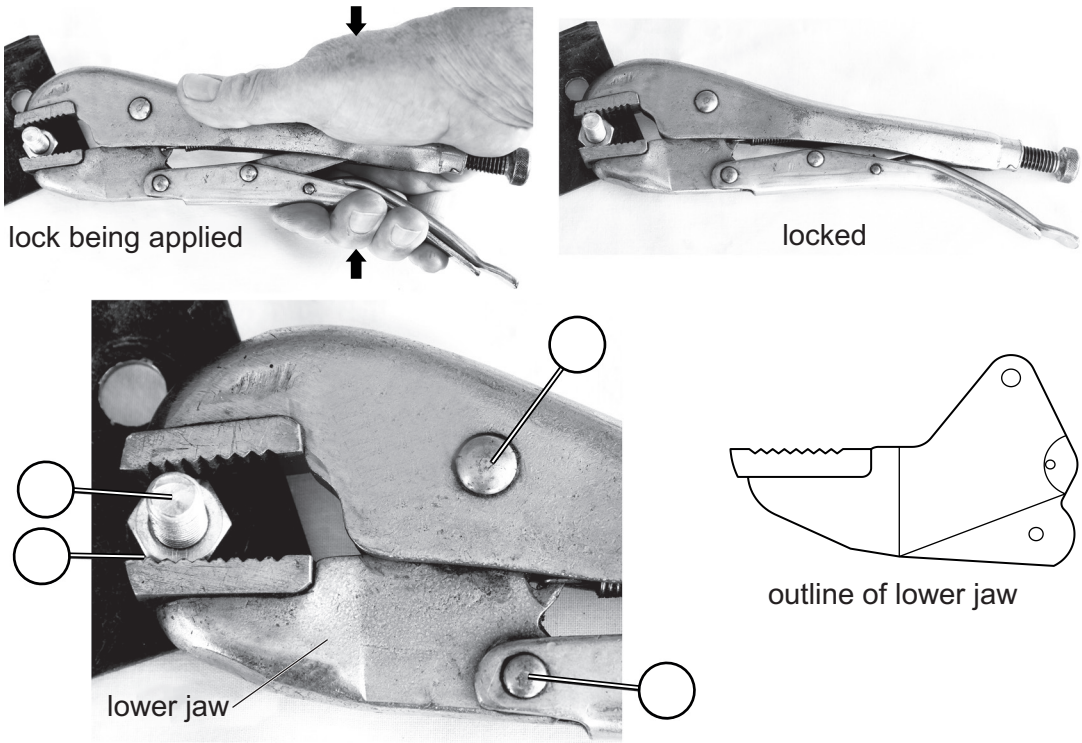


Fig. 4.1

(a) Add the letters **E**, **F** and **L** to three of the circles in Fig. 4.1 to show the position of the effort, fulcrum and load in the lever. [3]

(b) State the order of lever used in the lower jaw of the wrench.

..... [1]

5 State the type of motion which occurs in the following examples.

Clock pendulum .....

Cutting with a hacksaw .....
[2]

6 Give **two** reasons for using spur gears to transmit motion in a mechanism.

1 .....

.....

2 .....

.....
[2]

7 Fig. 7.1 shows a reed switch and the symbol for the switch.

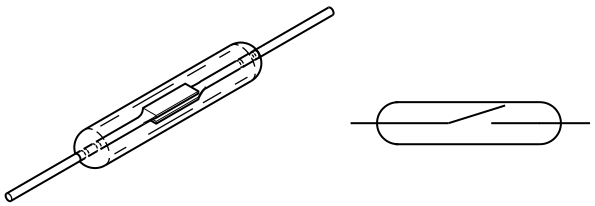


Fig. 7.1

Explain how the reed switch operates.

.....

.....

.....

..... [3]

8 Fig. 8.1 shows part of a circuit diagram.

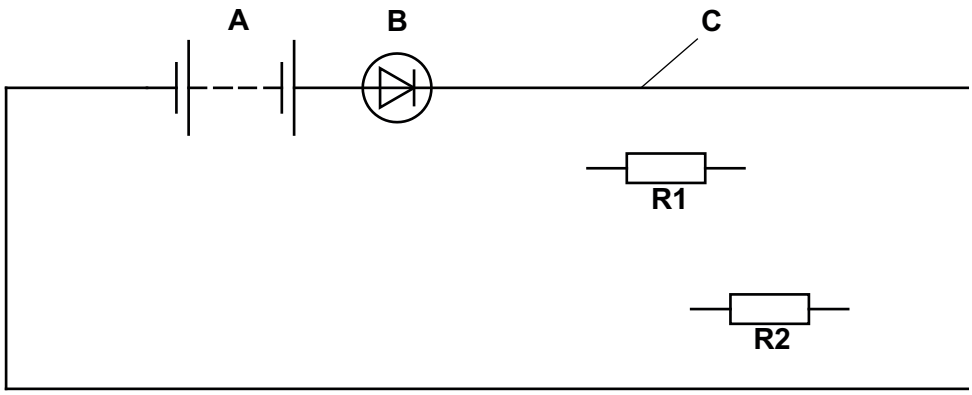


Fig. 8.1

(a) Identify the symbols **A**, **B** and **C**.

A .....

B .....

C .....

[3]

(b) Draw on Fig. 8.1 to show **R1** and **R2** connected in parallel to the supply voltage. [2]

Section B

Answer **one** question from this section.

9 Fig. 9.1 shows two lengths of softwood that are to be joined at 90° to each other.

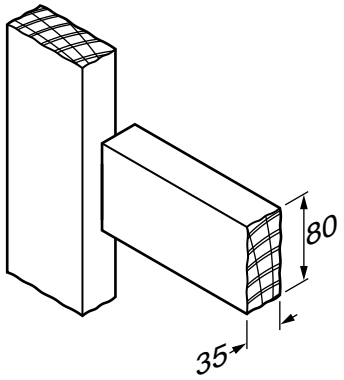


Fig. 9.1

(a) Use sketches and notes to show **two** different methods of joining the lengths of softwood.

[4]

(b) Corrugated plastic sheet as shown in Fig. 9.2 is often used as roofing on small buildings.

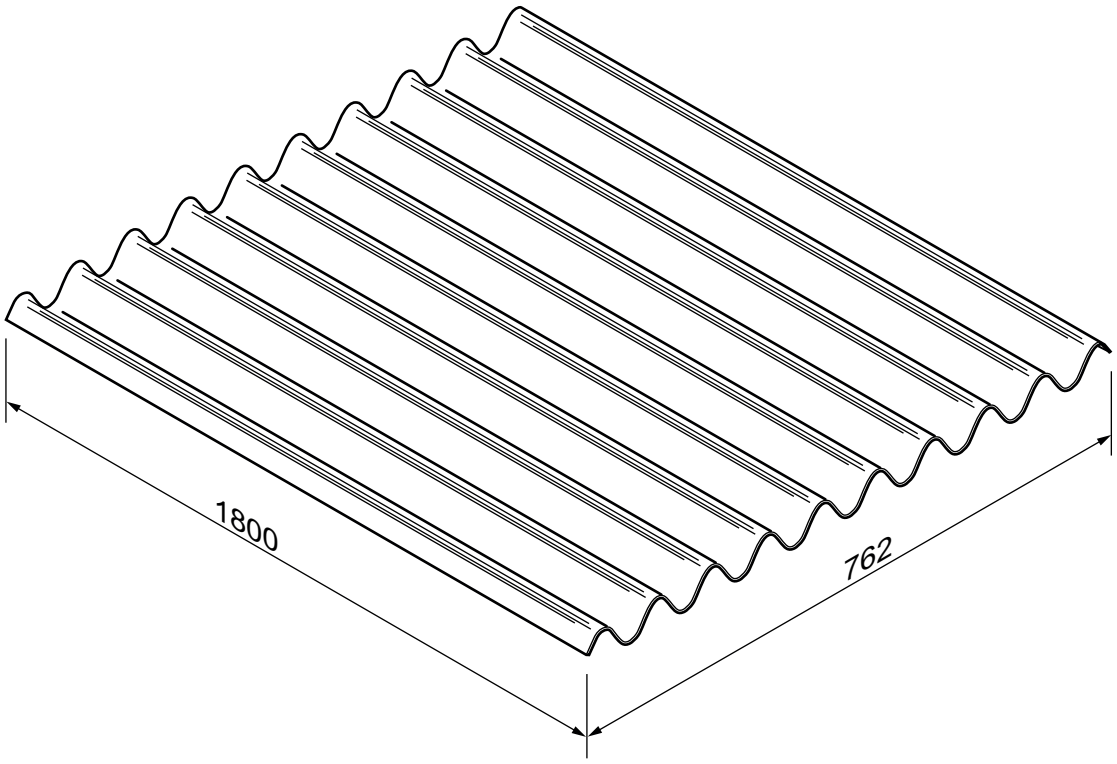


Fig. 9.2

(i) Describe **one** structural benefit of having corrugations on the sheet.

.....

.....

..... [2]

(ii) Draw on Fig. 9.2 to show where support beams should be placed to prevent the corrugated sheet from bending when it is used on a roof. [2]

(c) Fig. 9.3 shows a model girder bridge that will span a gap of 400 mm.
The model is to be made using resistant materials.

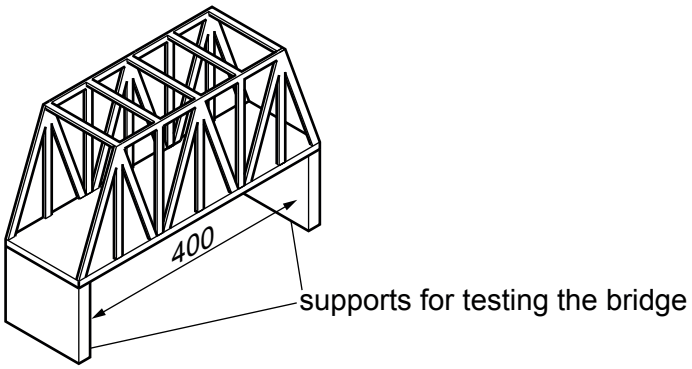


Fig. 9.3

(i) Name **one** resistant material that would be suitable for the model and give a reason for your choice.

.....

..... [2]

(ii) Describe how the material named in **part (c)(i)** could be joined.

.....

.....

.....

..... [2]

(iii) Use sketches and notes to show how the model could be tested and evaluated.

[3]

(d) Fig. 9.4 shows two different types of structure used to support wind turbines.

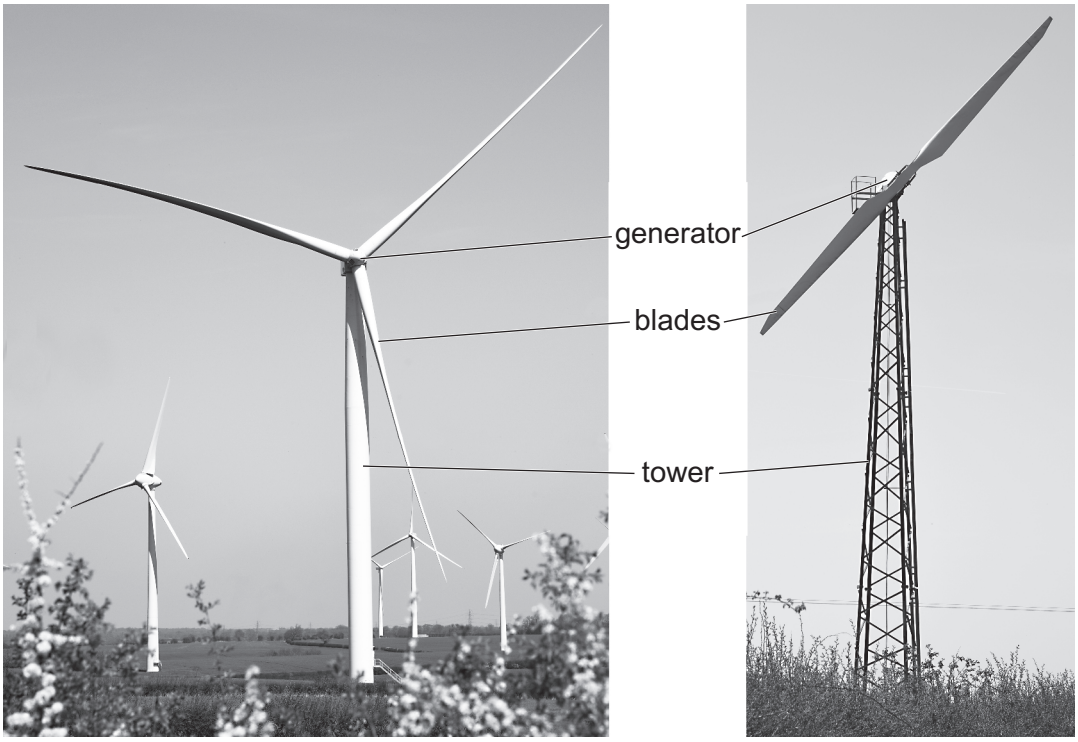


Fig. 9.4

(i) State the type of structure used for the tower on each of the turbines.

Turbine **A** .....

Turbine **B** .....
[2]

(ii) Name **one** stationary load that will act on the base of each tower when the blades are at rest.

..... [1]

(iii) Name **two** moving loads that will act on the wind turbines when they are generating.

1 .....

2 .....
[2]

(iv) Explain how the turbine towers in Fig. 9.4 maintain equilibrium.

.....

.....

..... [2]

(e) A tie bar in a roof truss is made from a piece of steel rod Ø12 × 1.5 m long.
When a load of 15 kN is applied the tie bar extends by 0.35 mm.
Calculate the strain in the tie bar.

Use the formula: $\text{Strain} = \dfrac{\text{change in length}}{\text{original length}}$

.....

.....

.....

.....

Strain = ... [3]

10 Fig. 10.1 shows a toy steam locomotive.

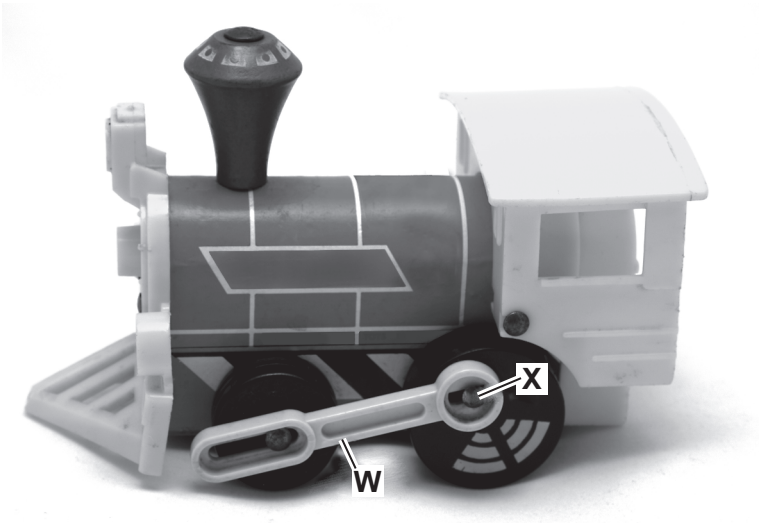


Fig. 10.1

(a) (i) Circle from the list below the mechanism that is formed by parts **W** and **X**.

rack and pinion **crank and slider** **worm and wheel**

belt and pulley **ratchet and pawl**

[1]

(ii) Give the conversion of motion produced by this mechanism.

..... to .....

[2]

(iii) Fig. 10.2 shows the base of the toy steam locomotive.

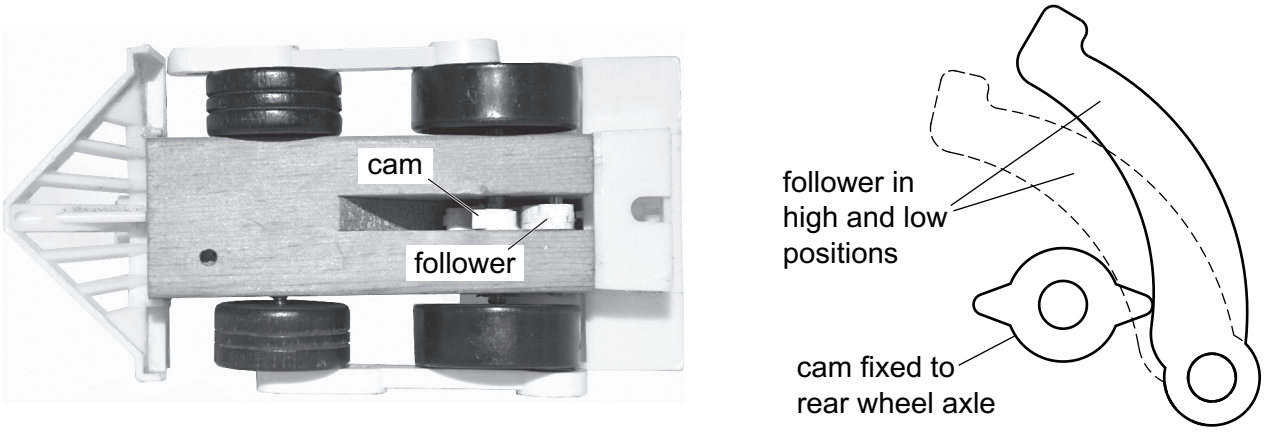


Fig. 10.2

The cam and follower are used to produce a sound in the toy.
State the number of times that the follower will be lifted for each rotation of the cam.

..... [1]

(iv) The cam and follower are both made from nylon.
Give **two** benefits of using nylon to make the parts.

1 .....

2 .....
[2]

(b) Fig. 10.3 shows bearings that can be found in a mechanism.

Fig. 10.3

(i) Explain why the roller bearing can withstand greater radial load than the ball bearing.

.....

.....

..... [2]

(ii) Give **one** reason for a bearing failing in a mechanism.

.....

..... [1]

(c) Fig. 10.4 shows a compound gear system.
The 18t and 60t gear in **B** are fixed together and the 15t and 60t gear in **C** are fixed together.

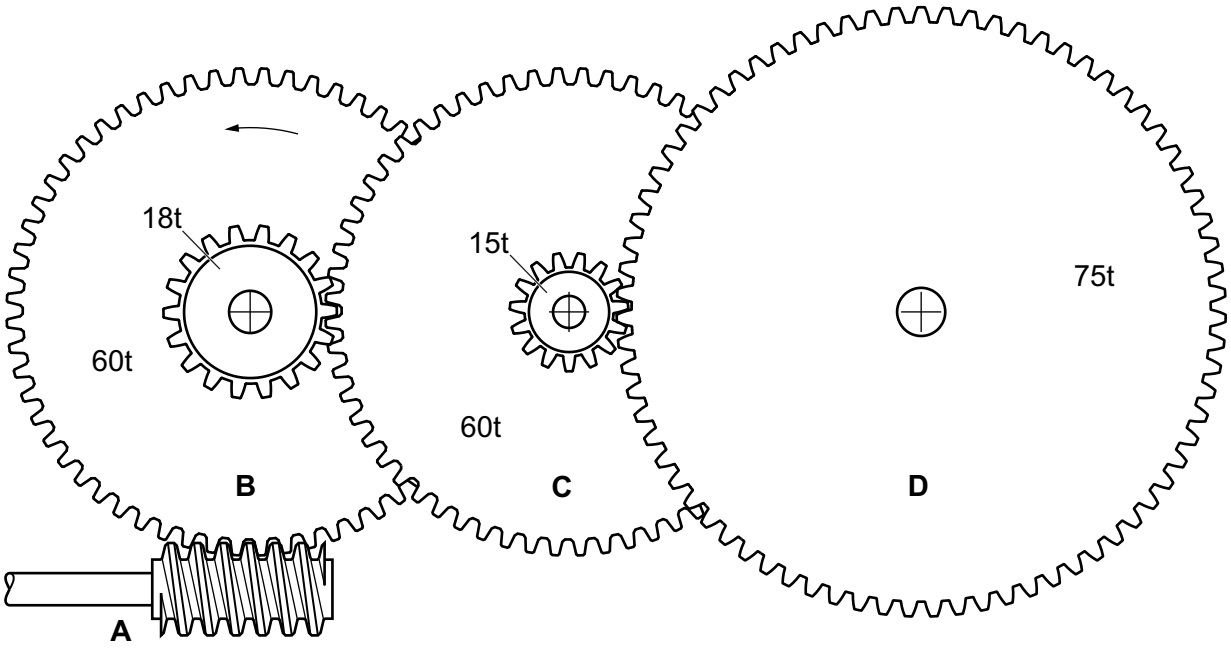


Fig. 10.4

(i) Mark the direction of rotation on the 75t gear. [1]

(ii) Give **two** reasons for using a worm gear in a mechanical system.

1 .....

2 .....

[2]

(iii) Calculate the velocity ratio for each stage in the system and complete Table 10.1.

.....

.....

.....

.....

Table 10.1

stage	velocity ratio
A to **B**	
B to **C**	
C to **D**	
A to **D**	

[4]

(d) (i) Compare the following methods of transmitting motion.
Give **one** advantage and **one** disadvantage for each method.

Chain drive

Advantage .....

Disadvantage .....

Pulley and round belt

Advantage .....

Disadvantage .....

Pulley and toothed belt

Advantage .....

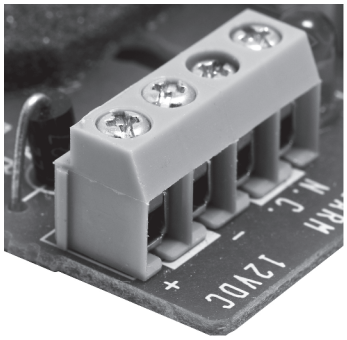
Disadvantage .....

[6]

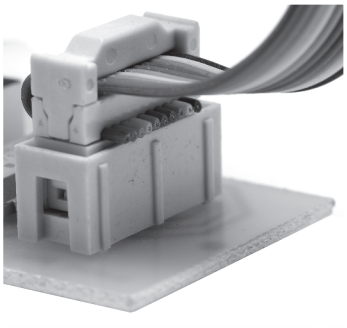
(ii) Use sketches and notes to show **one** method of tensioning a drive belt.

[3]

11 **(a)** Fig. 11.1 shows two methods of connection to a circuit board that do not require soldering.



terminal block



plug and socket

Fig. 11.1

(i) Give **one** different benefit for each method.

Terminal block .....

.....

Plug and socket .....

.....

[2]

(ii) Use sketches and notes to describe how a stranded connecting wire should be prepared for fitting to a terminal block.

[2]

(b) Fig. 11.2 shows part of a resistor colour code chart showing the values for the tolerance band.

	Colour	Tolerance
	Brown	1%
	Red	2%
	Blue	0.25%
	Gold	5%

Fig. 11.2

(i) Calculate the range of resistance values that can be expected in a batch of 10 kΩ resistors with a red tolerance band.

.....

.....

.....

..... [3]

(ii) Resistors with no resistance value (0 Ω) are often specified in PCB designs.
Give **two** reasons for using a 0 Ω resistor on a PCB.

1 .....

.....

2 .....

.....
[2]

(iii) A 9 V circuit is designed to carry a maximum current of 29 mA.
Calculate the power rating of a resistor that will be used in the circuit.
Use the formula: $P = VI$

.....

.....

..... [2]

(iv) Circle **two** 1 kΩ resistors from the list below that should **not** be used in the circuit.

1 kΩ 0.25 W **1 kΩ 0.3 W** **1 kΩ 0.125 W** **1 kΩ 3 W** **1 kΩ 100 W** [2]

[Turn over

(c) Fig. 11.3 shows a monostable circuit that uses a 555 timer IC.

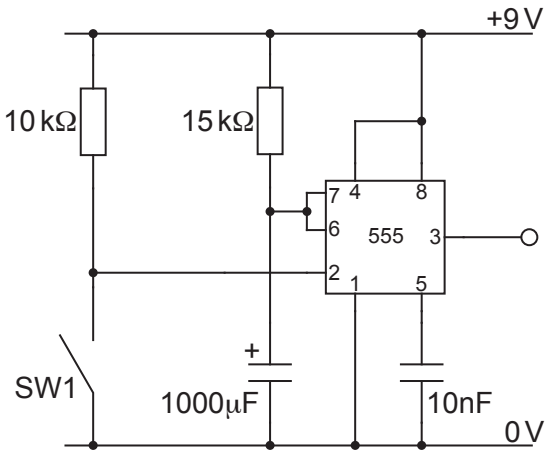


Fig. 11.3

(i) Calculate the time delay that the circuit will produce.
Use the formula: $t = 1.1\ RC$

.....

.....

.....

.....

..... [2]

(ii) Switch SW1 in Fig. 11.3 is closed 5 seconds after the circuit is switched on.
It remains closed for a further 5 seconds before opening again.

Draw on Fig. 11.4 to show the signals produced at the trigger (pin 2) and the output (pin 3) of the monostable.

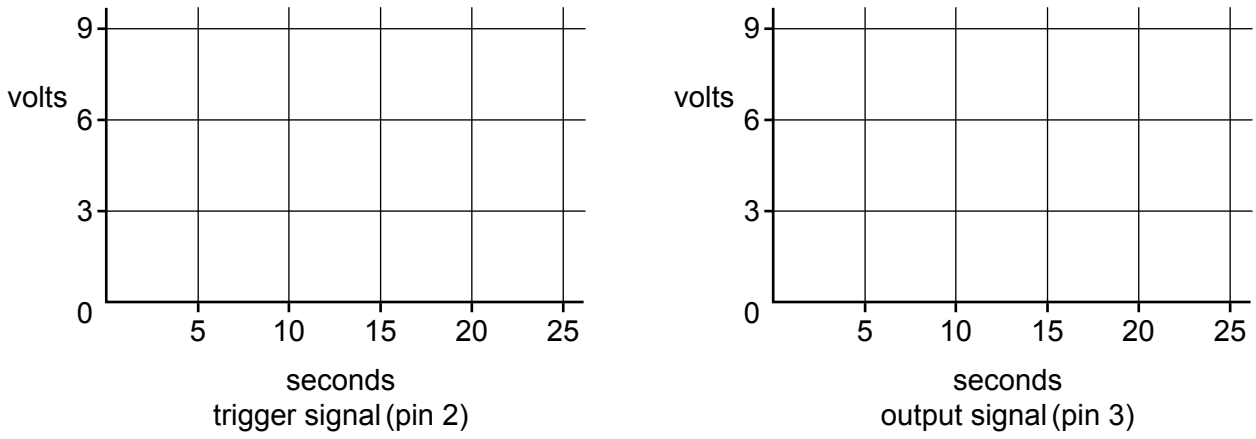


Fig. 11.4 [4]

(iii) Complete Fig. 11.5 to show how the buzzer with a protective diode would be connected so that it sounds when pin 3 is at 0 V.

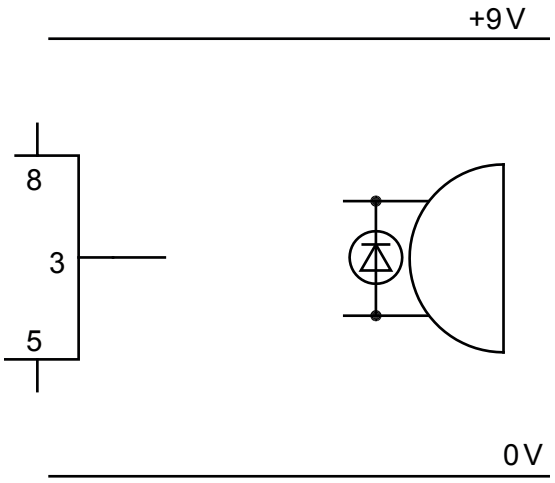


Fig. 11.5 [2]

(iv) State the purpose of the protective diode.

..... [1]

(d) A greenhouse control system uses a moisture sensor and a temperature sensor.
The water supply to the plants is switched on only when there is a low signal from the moisture sensor and a high signal from the temperature sensor.
Complete Fig. 11.6 to show a logic circuit which will give a high output when the two conditions are met.

moisture sensor

water supply

temperature sensor

Fig. 11.6

[3]

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